International Journal of Environment, Agriculture and Biotechnology
Vol-6, Issue-6; Nov-Dec, 2021

Journal Home Page Available: https://ijeab.com/
Journal DOI: 10.22161/ijeab

Peer Reviewed

The Performance and Haematological Indices of Broiler Chickens Fed Chromium Propionate, and Vitamin E Supplemented Diets

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Received: 25 Oct 2021; Received in revised form: 01 Dec 2021; Accepted: 07 Dec 2021; Available online: 17 Dec 2021

Abstract*— *Aims: This study investigates the out-turn of Chromium Propionate (CrProp) and vitamin E dietary supplementation on broiler chickens' performance characteristics and haematological indices.

Study Design: The completely randomised design was used for this study.

Methodology: Six hundred- and forty-day-old Cobb 500 broiler chickens were randomly assigned to eight dietary treatments (10 birds/replicate). A basal diet was fractionated into eight equal parts and labelled diets 1 to 8. Diets 1 to 4 were supplemented with 0, 0.4, 0.8 and 1.2 mg/kg CrProp, respectively. The diets 5 to 8 were supplemented with 200 mg/kg vitamin E; 0.4 mg CrProp+200 mg vitamin C; 0.8 mg CrPro+200 mg vitamin E and 1.2 mg CrPro+200 mg Vitamin E, respectively.

Results: The final body weight (FBW) of the birds fed diets 2, 3, 4,7 and 8 were significantly (P<0.05) higher than those fed the control diet and diet 5 and 6, and total weight gain (TWG) of the birds fed diets 2,4,7and 8 were significantly (P<0.05) higher than those fed the control and diet 3,5,6. The CrProp supplementation at 0.4, 0.8 and 1.2 mg/kg levels improved (P<0.05) the FBW, and supplementation at 0.4 and 1.2mg/kg levels improved (P<0.05) the TWG of the birds, compared to the control. The vitamin E supplementation (200mg/kg) does not improve (P>0.05) the FBW and TWG of the birds. The haematological indices showed a significant difference (P<0.05) across the diets. However, supplementation of CrProp at 0.8mg/kg affects MCV, WBC, Heterocyte and lymphocyte count, whileat 1.2mg/kg, the MCHC value was significantly affected. Including vitamin E at 200mg/kg improves the MCV and MCH. The combination of CrProp at 0.4mg/kg and 200mg/kg vitamin E increased(P<0.05) heterocyte count, while supplementation at 0.8mg/kg and 200mg/kg vitamin E improves WBC and lymphocyte counts. The packed cell volume improved significantly by CrProp supplementation at 1.2mg/kg and 200mg/kg vitamin E.

Conclusion: The growth of the broiler chicken is enhanced by 1.2 mg/kg CrProp, 200 mg/kg vitamin E and a combination of CrPropand vitamin E dietary supplementations with significant changes in haematological indices of the birds.

***Keywords*— Avian, blood, chromium, growth, supplements, Vitamin E.**

Authors' contributions

This work was carried out in collaboration among all authors. Authors OSO, OAA and CAC designed the study. Authors OAA and FBA performed the statistical analysis. Authors OSO, OAA and FBA wrote the protocol. Authors OSO and FBA wrote the first draft of the manuscript. All authors managed the analyses of the study. Authors OSO, OAA, FBA and SOA organised the literature searches. All authors read and approved the final manuscript

I. INTRODUCTION

Climate change can cause severe damage tofood production of animal origin for human consumption (Wang *et al*., 2017). Heat stress is considered one of the most critical environmental stressors that cause poor performance, imbalance of the oxidant/antioxidant system, and compromised immune and health statuses in egg-laying birds worldwide, namely, the poultry industry (Luo *et al.*, 2018; Sahin *et al.*, 2018). The tropical regions with high ambient temperature and humidity were more susceptible to high heat stress than the polar or temperate regions [Zhao *et al.* 2015]. Besides, meteorological factors such as temperature and humidity are significant factors that influencedomestic birds' production performance and haematological parameters [Ayo *et al*., 2011]. Notably, in Nigeria,the high environmental temperature may be responsible for reduced performance and increased mortality (Oguntunji and Alabi 2010; Yousaf *et a*l., 2019), and the provision of protection against heat which is usually in temporary light shades and radiation shield is usually inadequate [Ayo *et al.* 1996].

Feed consumption during heat stress is suppressed, leading to reduced nutrient intake (Khan *et al.* 2014). Increased mineral excretion from the body and decreases in the blood is significant consequence of heat stress, leading to deficiencies of these components in blood and tissues (Sahin *et al*., 2009). Heat stress may also increase the mortality rate, leading to economic losses (Khan *et al.*, 2011). However, the bodyweight of the broiler chickens raised under the heat-stressed environment is improved with dietary supplements and antioxidants [Zhao et al., 2015; Donkoh, 1989].

Presently, Chromium (Cr) is not yet generally considered an essential microelement for poultry. Still, it is thought that this trace element may play a beneficial nutritional and physiological role [Ognik*et al*., 2019]. Cr plays an essential role in the activation of certain enzymes and in stabilising the protein and nucleic acid [Ognik*et al.* 2019]. Khan et al. [2014] had earlier reported improved weight gain and reduced stress reactions in birds fed diets supplemented with Chromium. Despite these reported potentials of dietary Cr in poultry production, the National Research Council has not given its dietary inclusion recommended levels in poultry. Besides the beneficial effects of Cr, there is also a need for studies on the potentially toxic impact of wrong or inappropriate dosage in poultry. In addition, when combined with other antioxidants (e.g. vitamin E), Cr was reported to improve the stress influenced performance characteristics in laying chickens [Torki *et al*., 2017]. Vitamin E (VE) is a lipid-soluble antioxidant composed of eight compounds of similar structure, four tocopherols and four tocotrienols (TT) derivatives including α-, β-, γ- and δ-tocopherol and α-, β-, γ- and δ-tocotrienol. It is primarily bound to the hydrophobic interior of the cell membrane. It offers protection against injurious membrane oxidation by free radical scavenging [Birben*et al.* 2012] by donating an electron to lipid peroxidation products [Spiteller, 2006]. Vitamin E supplementation reduces the respiratory quotient in heat-stressed broiler chickens by supporting or enhancing increased fatty acid oxidation over the increase in protein-derived gluconeogenesis (Lin *et al.*, 2006)].

Therefore, the purpose of the present study was to evaluate the effects of dietary supplemental Chromium Propionate (CrProp) and vitamin E on the performance characteristics and haematological indices of broiler chickens.

II. MATERIALS AND METHODS

This feeding trial was carried out at the Avian Unit of The Federal University of Technology, Akure (FUTA) Teaching and Research Farm (TRF), during the peak of the dry season (i.e. between January and February 2020). The experimental pen's daily temperature-humidity index (THI) was 34.08ºC±1.36. The THI was calculated (Tao and Xin, 2003) using the formula: THI= $0.85*T_{db}+0.15*T_{wb}$ Where T_{db} = dry bulb temperature (ºC); T_{wb}= wet bulb temperature (ºC).

2.1 Chromium Propionate and Vitamin E Source

The Chromium Propionate powder (purity level = 98%) was manufactured by Chemlock Nutrition Corporation (Cincinnati, OH, USA.), which provides 0.4% Cr. The L-alpha-tocopherol powder (purity level = 100% pure (USP/FCC grade) was manufactured by the Burgoyne Burbidges& Co (Supplies and Services) Limited, England.

2.2 Experimental Diets and Animals

A basal diet each was prepared for the starter (age 1-3 weeks) and the finisher (age 4-6 weeks) phases (Table 1) and analysed for proximate composition [AOAC.1995]. The basal diets were sundered equally into eight parts and labelled diets 1to 8 and supplemented as follows:

DESCRIPTION OF EXPERIMENTAL DIETS/TREATMENTS (T):

Treatment	Chromium source	Levels of Chromium	Level of Vitamin E
T1	Control	Basal diet+ Nil (Control)	Nil
T2	Chromium Propionate	Basal diet +0.4mg/kg	Nil
T3	Chromium Propionate	Basal diet + 0.8mg/kg	Nil
T4	Chromium Propionate	Basal diet + 1.2mg/kg	Nil
T5	Chromium Propionate	Basal + Nil	200mg
T6	Chromium Propionate	Basal diet +0.4mg/kg	200mg
T7	Chromium Propionate	Basal diet +0.8mg/kg	200mg
T8	Chromium Propionate	Basal diet +1.2mg/kg	200mg

2.3 Growth Performance

The body weights of the broiler chickens were measured on a weekly interval. The body weight gain was calculated by subtracting the birds' initial body weight from their final body weight and the initial body weight. The feed intake was also estimated by subtracting the quantity of feed given from the feed leftover. The total weight gain(TWG) was calculated by subtracting the initial weight from the final body weight.

2.4 Blood Sample Collection and Analysis

On day 42 of the experiment, three birds per replicate were randomly chosen, labelled, and phlebotomised with a syringe and needle via the wing vein.About 4 ml of blood was pass Out into Ethylenediaminetetraacetic acid bottles for haematological indices examination. The haematological studies were performed within 120 minutes post bleeding [Shastry.,1983];for red blood cells (RBC), packed cell volume (PVC), haemoglobin concentration (Hbc), White blood cells (WBC), granulocytes (GRA), lymphocytes (LYM) and monocytes (MON).

Table 1. Composition of the experimental diets

Ingredients (%)	Starter feed	Finisher diet
Maize	52.35	59.35
Rice bran	0.00	6.00
Maize bran	7.00	0.00
Soybean meal	30.00	24.00
Soy oil	3.00	3.00
Fish meal	3.00	3.00
Limestone	0.50	0.50
Bone meal	3.00	3.00
Salt	0.30	0.30
Premix	3.00	3.00
Methionine	0.30	0.30
Lysine	0.25	0.25
Nutrient composition (%)		
*Crude protein	22.18	20.03

Metabolizable energy (Kcal/kg)	3018.89	3108.10
Methionine	0.68	0.66
Lysine	1.36	1.24
Available phosphorus	0.45	0.33
Calcium	1.01	0.99

2.5 Data Analysis

All data were subjected to analysis of variance from the General Linear Model stratagem for complete randomised design with 4 CrProp levels x 2 Vitamin Elevels factorial setting of treatments. The data were checked for CrProp, Vitamin Eand interaction of CrProp with Vitamin E. When the treatment out-turn was significant (P<0.05), means were differentiated using Duncan's multiple range test using SPSS version 28.

III. RESULTS AND DISCUSSION

The final body weight (FBW) of the birds fed diets 2, 3, 4,7 and 8 were significantly (P<0.05) higher than those fed the control diet and diet 5 and 6, and total weight gain (TWG) of the birds fed diets 2,4,7and 8 were significantly (P<0.05) higher than those fed the control and diet 3,5,6. The improved final weight recorded in the broiler chickens fed diet 2 (0.4 mg/kg Cr Prop) , diet 3 (0.8 mg/kg Cr Prop), diet 4(1.2 mg/kg Cr Pro) diet 7 (0.8 mg/kg Cr Prop+200 mg/kg vitamin E) and diet 8 (1.2 mg/kg Cr Prop+200 mg/kg vitamin E), compared to those fed the control diet and diet 5 (200 mg/kg vitamin E) and diet 6 (0.4 mg/kg Cr Prop+200 mg/kg vitamin E) suggests Cr Prop supplementation at 1.2 mg/kg have growth performance-enhancing effects on the broiler chickens. Quite a few studies show that chromium Propionate dietary supplementation has a promoting effect on the growth performance of chickens [Kroliczewska*et al.*, 2005; Jackson *et al.*, 2008]. This result further unfolds another beneficial biological activity of Chromium when used as a dietary supplement [Khan *et al.* 2014]. CrProp improves growth by increasing insulin sensitivity, initiation of microRNA translation and consequently, the improvement in the stimulation of muscle protein synthesis [O'Connor *et al.* 2003). The vitamin E supplementation (200mg/kg) does not significantly (P>0.05) improve the final body weight, compared to the control. The feed intake of the broiler chickens fed diet 4 (1.2 mg/kg CrProp) increased (P<0.05) compared to those fed the rest diets. The 1.2 mg/kg CrPropsupplementation increased (P<0.05) the feed intake of the birds. In contrast,the interaction between CrProp and vitamin E significantly (P<0.05) affects the feed conversion ratio at 0.4 mg/kg Cr Prop and 0.8 mg/kg Cr Prop+200 mg/kg vitamin E.

Table 3 shows that the haematological indices of the birds, MCHC, WBC, Heterocyte, and lymphocyte counts were significantly (P<0.05) affected by CrProp. In contrast, vitamin E supplementationdoesaffect (P<0.05) the MCV, MCH values. The study showed that the CrProp in combination with vitamin E significantly (P<0.05) affects MCV, MCH, WBC and lymphocyte counts. The results of most blood indices across the various dietary treatments in this study show the supports of the CrPropand vitamin Eat the levels used in this study for normal blood formation. Granulocytes (neutrophils, eosinophils, and basophils) are phagocytes and possess granules of enzymes that digest the invading microbes.

Table 2. Effects of Chromium Propionate and vitamin Edietary supplementation on the performance characteristics of broiler chickens

CrProp (mg/kg	Vitamin E (mg/kg)	Initial weight (g/bird)	Final body weight (g/bird)	Total weight gain (g/bird)	Daily weight gain (g/bird)	Feed intake (g/bird)	Daily feed intake (g/bird)	FCR
Level of CrProp								
0		39.37±0.26	2601±58.61[b]	2562.60±58.63[b]	45.79±1.05[b]	5863.70±95.98[c]	104.71±1.71[c]	2.29±0.06
0.4		39.22±0.29	2679.17±106.51[b]	2639.95±106.26[b]	47.14±1.90[ab]	5976.47±82.30[b]	106.72±1.47[bc]	2.28±0.08
0.8		39.39±0.17	2880.97±67.55[ab]	2841.58±67.54[ab]	50.74±1.21[a]	6166.47±44.88[ab]	110.12±0.80[b]	2.17±0.04
1.2		40.29±0.51	2917.84±93.42[a]	2877.56±93.28[a]	51.38±1.67[a]	6403.90±121.41[a]	114.36±2.17[a]	2.23±0.06
Vitamin E								
	0	39.78±0.32	2817.20±49.80	2777.42±49.62	49.60±0.89	6075.97±91.97	108.50±1.64	2.19±0.02[b]
	200	39.36±0.15	2722.78±81.89	2683.42±81.81	47.92±1.46	6129.29±80.52	109.45±1.44	2.30±0.05[a]
CrProp x Vit E								
0	0	39.28±0.57	2667.43±94.15	2628.15±93.82[b]	46.93±1.68[b]	5734.99±152.69[b]	102.41±2.73[b]	2.18±0.06[a]
0.4	0	39.64±37.41	2873.26±37.41	2833.62±37.41[a]	50.60±0.67[a]	6032.07±23.64[ab]	107.72±0.42[ab]	2.13±0.02[a]
0.8	0	39.25±0.33	2832.94±113.37	2793.69±113.33[ab]	49.89±2.02[ab]	6153.27±88.70[ab]	109.88±1.58[ab]	2.21±0.06[b]
1.2	0	40.94±0.91	2895.15±124.49	2854.22±123.77[a]	50.97±2.21[a]	6383.57±211.99[a]	113.99±3.79[a]	2.24±0.04[b]
0	200	39.47±0.01	2536.51±63.47[ab]	2497.04±63.46[b]	44.59±1.13[b]	5992.40±78.63[b]	107.01±1.40[b]	2.40±0.03[c]
0.4	200	38.80±0.50	2485.07±132.84[b]	2446.27±132.46[b]	43.68±2.37[b]	5920.88±173.84[b]	105.73±3.10[b]	2.43±0.09[c]
0.8	200	39.53±0.14	2929.00±87.51[a]	2889.47±87.58[a]	51.60±1.56[a]	6179.67±45.05[ab]	110.35±0.80[ab]	2.14±0.05[a]
1.2	200	39.63±0.14	2940.53±166.22[a]	2900.90±166.26[a]	51.80±2.97[a]	6424.22±168.36[a]	144.72±3.01[a]	2.23±0.13[b]
Statistical significance								
CrProp		0.10	0.03	0.03	0.03	0.01	0.01	0.35
Vitamin E		0.20	0.24	0.24	0.24	0.58	0.58	0.04
CrProp x Vitamin E		0.24	0.04	0.03	0.02	0.04	0.03	0.05

Means with a different superscript in the same column are significantly ($P<0.05$) different; Cr Prop: Chromium Propionate

Table 3. Effects of Chromium Propionate and vitamin Edietary supplementation on the haematological indices of broiler chickens

CrProp (mg/kg	Vitamin E (mg/kg)	PCV (%)	RBC ($x10^6/1$)	HBc (g/d1)	MCHC (g/d1)	MCV (fl)	MCH (pg/cell)	WBC ($x10^9/1$)	HET (x109/1)	LYM ($x10^9/1$)	MON ($x10^9/1$)
Level of CrProp											
0		37.17±0.87	4.45±0.56	12.40±0.29	33.40±0.34	89.83±11.29^a	29.97± 3.77	4.47±0.94^b	2.08±4.19	2.30±0.42^b	0.08±0.02
0.4		38.17±1.64	4.90±0.43	12.73±0.55	33.42±0.34	81.52±8.73^{ab}	27.15±2.91	4.33±1.07^b	2.10±0.71	2.13± 0.39^b	0.08±0.05
0.8		40.67±1.17	4.95±0.65	13.57±0.39	33.83±0.36	87.67±8.70^a	29.25±2.89	8.88±1.47^a	3.20±0.52	5.60±1.05^a	0.11±0.04
1.2		39.67±1.09	4.98±0.09	13.22±0.37	34.45±0.15	79.78±2.87^b	26.58±0.96	5.87±1.41^{ab}	2.08±0.53	3.70±0.45^{ab}	0.08±0.04
Vitamin E											
	0	38.50±0.84	4.66±0.26	12.84±0.28	33.51±0.18	85.10±4.53	28.37±1.51	6.27±0.71	2.85±0.34	3.33±0.50	0.10±0.03
	200	39.33±0.98	4.98±0.38	13.12±0.33	34.04±0.28	84.30±6.93	28.11±2.31	5.51±1.22	1.88±0.43	3.53±0.80	0.08±0.03
CrProp x Vit E											
0	0	36.33±0.88	5.23±0.90	12.13±0.30	33.57±0.32	73.27±11.55^b	24.43±3.85^b	6.40±0.29^{ab}	3.17±0.26	3.13±0.29^{ab}	0.11±0.02
0.4	0	40.00±2.65	4.07±0.27	13.37±0.88	33.17±0.28	98.73±6.28^a	32.90±2.08^a	6.47±0.90^{ab}	3.47±0.78	2.87±0.20^b	0.13±0.10
0.8	0	40.00±1.53	4.30±0.21	13.33±0.52	33.10±0.26	93.33±4.60^{ab}	31.13±1.54^{ab}	8.67±1.79^a	3.17±0.79	5.43±1.33^a	0.09±0.05
1.2	0	37.67±0.67	5.03±0.20	12.53±0.23	34.20±0.20	75.07±3.29^b	25.00±1.10^b	3.53±0.52^b	1.60±0.50	1.90±0.46^b	0.05±0.02
0	200	38.00±2.65^b	3.67±0.59	12.67±0.91	33.23±1.16	106.40±26.26^a	35.50±8.75^a	2.53±1.33^a	1.00±0.72^b	1.47±0.57^b	0.06±0.02
0.4	200	36.33±1.76^b	5.73±0.39	12.10±0.59	33.67±0.66	64.30±6.75^c	21.40±2.25^c	2.20±0.58^b	0.73±0.18^b	1.40±0.40^b	0.02±0.01
0.8	200	41.33±2.03^a	5.60±1.27	13.80±0.67	34.57±0.19	82.00±18.03^b	27.37±5.99^b	9.10±2.76^a	3.23±0.84^a	5.77± 1.93^a	0.12±0.07
1.2	200	41.67±1.20^a	4.93±0.03	13.90±0.42	34.70±0.06	84.50±2.86^b	28.17±0.93^b	8.20±2.05^a	2.57±0.97^a	5.50±1.15^a	0.11±0.09
Statistical significance											

CrProp	0.19	0.79	0.20	0.05	0.04	0.71	0.02	0.05	0.01	0.96
Vitamin E	0.48	0.45	0.49	0.07	0.91	0.91	0.47	0.06	0.77	0.65
CrProp level*Vitamin E	0.05	0.06	0.15	0.19	0.02	0.02	0.02	0.46	0.05	0.45

Means with a different superscript in the same column are significantly (P<0.05) different; CrPic: Chromium Propionate; PCV: Packed cell volume; RBC: Red blood cell; HBc: Haemoglobin concentration; MCV: Mean cell volume; MCH: Mean cell haemoglobin; WBC: White blood cells; GRA: Granulocytes; LYM: Lymphocytes; MON: Monocytes; SEM: Standard error of the mean

IV. CONCLUSION

The 1.2mg/kg CrProp dietary supplementations improved the final body weight, total weight gain, daily weight gain and daily feed intake of the broiler chickens. Also, the 200 mg vitamin Esupplementation did not enhance the final body weight, total weight gain, daily weight gain and daily feed intake of the broiler chickens.

ETHICAL APPROVAL

This work was approved by the Research and Ethics Committee of the Animal Production and Health Department, The Federal University of Technology, Akure, Nigeria.

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